JET PROPULSION

By FRED KATTERHEINRICH, AERO. E III

NOW it is possible, without being classed as an impractical dreamer, to talk about the future when man may travel through space by rocket propulsion with speeds heretofore undreamed of, for men in the field of aeronautics have recently made a radical development in the propulsion of aircraft. This development is that of jet propulsion. On January 7, 1944, the U. S. Army Air Forces issued the announcement of the development of a successful jet propelled airplane.

Careful discrimination should be made between jet propulsion and the rocket propulsion before going into more detail in this article. Many have come to the erroneous conclusion that the sensational new plane is a rocket. One might say they are second cousins, however, the chief difference is the source of oxygen for combustion. The rocket contains all the fuel plus a concentrated supply of oxygen, usually in liquid form, thereby not being limited to altitudes of sufficient atmospheric oxygen supply. Jet propulsion, on the other hand, is a complex system, which although varying in the arrangement of its units, operates in a cycle using the air outside the plane as the main fluid element and source of oxygen.

The principle of jet propulsion is identical with that of the normal propeller. Both produce thrust to move the aircraft forward by sucking in a mass of air and expelling that air rearward at an increased or accelerated velocity. In the case of the jet, air is sucked into an orifice, then heated and expanded and ejected at high velocity through the jet nozzle. This principle has already been applied in planes before the new jet propulsion plane was introduced to the public. It is used in the liquid-cooled aircraft engines where the radiator or tunnel functions as a jet, sucking in air which in turn becomes heated as it passes over the engine and leaving the exhaust at a higher velocity than that on entering. This more than makes up for its own drag. The rear-slanted exhaust stacks on some fighter planes have given sufficient added thrust to the plane so as to increase its speed ten or more miles per hour.

All of the more detailed principles of jet propulsion can be traced back to one fundamental law of physics. This law is that of Newton which states that for every action there is an equal and opposite reaction. The pressure inside the chamber of combustion drives the gases out and thus a thrust is exerted on the chamber and hence on the plane itself.

In brief the features of the jet propulsion plane are these. Air is sucked into an opening forward that of the process chamber. This may initially be drawn in by a starting engine. It passes to the compression chambers and is there highly compressed which is followed by injection of fuel. The fuel ignites, creating a much higher gas pressure. The burning gases pass through the jet at extremely high velocities exerting the thrust that drives the plane. This gas may first be used to drive a gas turbine before it is released through the jet and in turn serve as the auxiliary or sole power for operating the compressors.

The jet propelled plane has already shown many advantages over the blade propelled plane. The new Bell plane, equipped with two jet engines, flies between 500 and 600 miles an hour, a speed nearly 100 miles faster than any other type of aircraft flown. The propeller blade is less efficient at higher altitudes because the air becomes so thin that the blade can not "bite." Jet propulsion, on the other hand, finds thin air an advantage. The thin air causes less resistance than at lower altitudes and permits the plane to fly faster providing it can attain the additional thrust. Jet propulsion offers this additional thrust for at the low pressure conditions of high altitude the jet gases may be discharged with higher velocities. If, however, the air becomes too thin, insufficient oxygen is present for compression and sustaining combustion. The jet propelled plane is not limited to the speed of sound as is the blade propelled plane. If higher speeds are to be attained by the conventional propeller, the propeller must be larger and the tips approach supersonic velocities. (Supersonic velocities are above the velocity of sound which is 750 m.p.h.) Extremely high resistance to flight is encountered at this velocity because of shock waves which occur by action of the propeller.

According to Brigadier General B. W. Chidlaw, Chief of the Materiel Division of the Army Air Forces, there are two distinct sensations in flying the jet propelled aircraft—lack of noise and lack of vibration. The plane is not noiseless, in fact, some observers on the ground have described the sound of the plane as a whistling tea kettle, however, the elimination of the propellers and the fact that the noise from propulsion is to the rear makes for quietness in the cockpit and reduces pilot fatigue. One can conclude that this type plane is comparatively safe, for several hundred flights have been made to date by American and British pilots testing the jet propelled military plane and all without a single mishap.

Ordinary kerosene or fuel oil may be used for fuel instead of the high octane gases. Experiments have even been made using powdered coal, however, this proved none too successful because of the abrasive effect caused by the products of combustion. The use of these fuels does not assert that the plane is efficient and economical to operate. On the contrary, the plane is far from efficient in its present stage and leaves much room for improvement. The gases leave the combustion chamber at high velocity, say 6000 feet per second, and produce a thrust, T, by reaction. Suppose the airplane is moving at 600 feet per second or approximately 400 m.p.h. Then the work done on the airplane is (T x 600); the work done on the gases is (T x 6000). The efficiency is the one divided by the other—only 10%.

This exposes the chief difficulty of the jet-reaction principle. The gases come out too fast and carry away too great a proportion of the energy of combustion.

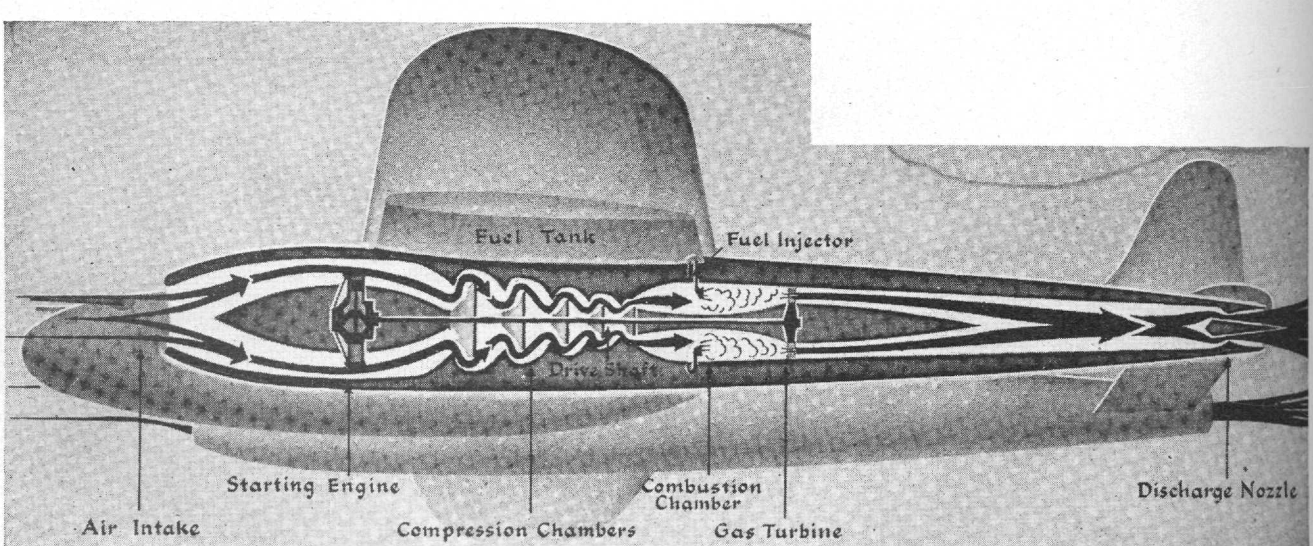
Possible remedies are very great speed of the plane itself which means higher altitudes and some way to mix great quantities of air with the jet. In this way the mixture of burned gases and air would leave the jet-reaction engine at very much lower speeds and greatly increase the external efficiency.

The possibilities of the jet-reaction principle have long been known and various types and ideas of jet propulsion have been developed with it, but only recently was it successfully developed for aircraft. The first experimenters who actually made flights with their machines were S. Campini of Italy and Capt. Frank Whittle of England. Campini began working on plans for a jet propelled airplane in 1932. By 1938 the plans for the plane were finished and in 1940 Campini made a flight of ten minutes with his 8,800 pound machine. Capt Frank Whittle took out a patent in 1930 but industrialist after industrialist turned down the invention and for five years Whittle did nothing about the patent. Finally, in 1935, Whittle received help of two former R. A. F. men and together they built an engine which was ground tested in 1937. In 1939 the British Air Ministry placed an order with them for such a plane. By May 1941 the first plane was built and sucessfully flown. In July of the same year the British informed the United States Army and sent an engine for experimentation and further development. Eight months later the engine was ready for testing and by September of 1942, Bell Aircraft Company built the first fuselage to house two of the new engines. Since then the plane has gone through numerous modifications and improvement which make it practically ready for combat use. This Bell plane is the same made mention of earlier in the article.

In basic principle, there was little difference between Whittle and Campini. The Whittle design has the advantage that a very simple and effective gas turbine is substituted for an internal-combustion engine. Capt. Whittle has advanced other plans but military secrecy does not permit description of the exact plans employed.

The future of jet propulsion looks promising. An excellent characteristic of jet propulsion which gives promise of its success is that its efficiency increases at higher speeds and higher altitudes. If efficiency-forward speed curves were plotted of

(Continued on page 30)



—*Courtesy Missouri Shamrock*

Diagram of a jet-propelled plane

JET PROPULSION

(Continued from page 8)

the conventional plane and the jet propelled plane they would show a decrease of efficiency at a comparatively even rate for the conventional plane and an increase of efficiency at an increasing rate for the jet propelled plane. The jet propulsion may also solve our problems of take-offs with heavy pay-loads by using jets in assisting the heavy cargo planes to leave the ground in shorter distances. Finally, jet propulsion gives promise of a new era of transportation, transportation by air of huge quantities and to such extent that it can prove fair competition to ground and water transportation for most types of cargo. The success of jet propulsion will prove itself a pioneer to another future phase of air transportation, that of rocket transportation.